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## A Followup Survey of Winter Injury in the Forests of Montana, 1990

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# *A FOLLOWUP SURVEY OF WINTER INJURY IN THE FORESTS OF MONTANA, 1990*

***by***

***William H. Klein, Entomologist***
***and***
***Nancy J. Campbell, Entomologist***

## INTRODUCTION

This report is the second in a series of surveys to attempt to evaluate some of the effects of severe winter weather on coniferous stands in Montana. The initial survey was conducted in the summer and fall of 1989, and reported in January 1990[1]. That report explained in detail the survey methods and procedures, some of which will be summarily mentioned in this report.

## BACKGROUND

During late January and early February 1989, an arctic continental air mass containing extremely low temperatures moved into Montana and portions of other Northern Rocky Mountain States. Immediately preceeding this arctic air intrusion, Montana and portions of neighboring states experienced an unseasonal warming trend which probably preconditioned many trees to the damage that followed. Additionally, 3 consecutive years of drought (1986 to 1988) could well have further decreased the trees' resistance to severe physiological stress.

Most of the damage occurred in mature and overmature lodgepole pine stands east of the Continental Divide in portions of the Helena, Deerlodge, and Lewis and Clark National Forests. Conspicuous, but less severe damage, occurred in parts of other National Forests west of the Divide, including the Flathead National Forest. Besides lodgepole pine, practically all conifers were affected to varying degrees in limited locales; species affected include ponderosa pine, Douglas-fir, Engelmann spruce, western larch, subalpine fir, and western white pine. Many fruit orchards, particularly in the Flathead Valley, as well as ornamental trees and shrubs in urban and suburban areas, were badly damaged or killed outright.

The pattern or nature of this widespread winter damage did not fit the "red belt" pattern; damage seemed to occur without respect to elevation, aspect, or topographic position.

During the spring and summer of 1989, crowns of the injured trees began to discolor. Aerial sketchmap surveys were done by Zone and Regional personnel to locate, identify, and record visible damage. These findings set the stage for this survey.

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[1]Klein, William H. 1990. A Survey of Winter Damage in the Forests of Montana, 1989. USDA, Forest Service; Northern Region; Missoula, MT. Report 90-6, 11 pp., illustrated.

## METHODS

During the summer and fall of 1989, three types of surveys were done in some of the most heavily damaged areas, as detected and delimited by the aerial reconnaissance teams.

Stand Damage Assessment Surveys provided ready estimates of overall tree damage in local areas. Once located, a transect or series of parallel transects were run through the stands with observations made of five-tree groups at periodic intervals, usually 2 or more chains. Each tree crown was observed with binoculars and classified as to degree of damage and presence or absence of new growth. One hundred trees were observed and rated in each area. The trees were not tagged for re-examination.

Individual crown condition was classified into four general categories, depending on the percent of crowns containing either green or damaged (discolored) foliage, as follows:

(1) < 25 percent; (2) 26 to 50 percent; (3) 51 to 75 percent; (4) > 76 percent.

Some examples of how the trees were recorded by live to dead crown ratio follow:

1. A crown completely green: 4,0, since more than 76 percent of the crown is live (4) and there are no dead (0) needles. Similarly, a crown completely dead would be rated 0,4.

2. A crown estimated to be approximately 30 percent green with the remaining part (70 percent) dead: 2,3, since more than 26 percent of the crown is alive (2) and between 51 and 75 percent of the crown is dead (3).

3. A crown estimated to be 50 percent green would be rated 2,2.

Stand Re-examination Surveys provide a followup to the eventual condition of winter-injured trees over time. In each area, 25 trees were selected to represent a range of damage conditions, but in many of the badly affected areas, this was not always possible. Each tree was individually observed and judged using the above criteria, and marked with metal tags for relocation and re-examination at a later date.

Photo Plots were established to provide a visual record of trees showing winter injury in 1989 and subsequent changes in appearance and condition that might follow. Plot centers were marked with stakes, and the scene replicated in 1990 by matching it with a photo print from the initial survey.

## FINDINGS AND OBSERVATIONS

Some of the more relevant findings of the initial 1989 survey follow:

1. Mature and overmature lodgepole pine appeared to suffer the heaviest crown damage; consequently, those trees receiving the higher damage estimates were not expected to survive beyond 1990. Trees along stand openings were more heavily damaged than trees within the stand (Figure 1.).

Figure 1.--Lodgepole pines adjacent to openings suffered heavier damage than those within the stand. Damage in 1989 (above) and 1990 (below). Note almost complete recovery of lodgepole saplings in the reproduction area.

2. What little new growth observed was delayed, and thought to be a sign of stress rather than survival.

3. Bark beetles, in particular the mountain pine beetle in lodgepole pine, were not considered a significant future problem in the injured stands. Western spruce budworm populations in damaged Douglas-fir stands were expected to decrease, since their food supply was severely limited.

4. More definitive information on tree condition and survival would be obtained in 1990 by revisiting the re-examination and photo plots.

Stand assessment plots were not revisited, since the trees were not permanently marked and could not be accurately relocated.

In early September 1990, all seven re-examination plots were revisited, and each tree was observed with binoculars and classified as in 1989 as to crown condition and presence of new growth. All photo plots, with only one exception, were located and rephotographed.

Table 1. shows the changes in crown and tree condition as recorded in the seven re-examination plots in 1989 and 1990. As expected, lodgepole pine experienced the heaviest mortality. Seventy-five percent of the lodgepole pine on these plots were dead in 1990, even though most had exhibited some new growth in 1989. Almost half of the spruce and Douglas-fir died in 1990, but western white pine, even though receiving high damage estimates in 1989, i.e., 1,3 and 1,4, appeared to completely recover in 1990. Somewhat surprising, a few lodgepole pines (Bryan Creek, Bullion Park, and Granite Butte) with mostly green crowns and having some new growth, either deteriorated or died in 1990.

The above survivor/mortality ratios can be extrapolated to represent the conditions of the trees examined in the stand assessment plots in 1989, with reasonable confidence.

In all plots and with all species, with the exception of western white pine, the presence of new growth in late 1989 did not portend survival.

It was apparent during the 1990 followup survey, particularly in the lodgepole pine stands, that even the most severely injured trees showed some resurgence of activity in 1990 in the form of both vegetative and reproductive buds. Most of the new growth was in the upper reaches of the crown, and in many cases there was a proliferation of immature cones. This was most evident in lodgepole pine, since they retained most of their needles while Douglas-fir and Engelmann spruce did not. Both needles and cones appeared to reach their maximum annual growth, indicating that many were dying or had died upon cessation of the normal growing season.

An interesting and, heretofore, unreported phenomenon was noticed in two lodgepole stands and in the Engelmann spruce stands. With both species, the outer bark of the lower boles of the dead trees appeared stained and upon closer examination, were, in some trees, damp to the touch. With some lodgepoles, a hatchet chop would produce a stream of liquid. The boles of other lodgepoles produced a milky exudate having the consistency of soft custard (Figure 2.).

This phenomenon helped support the conjecture that the distressed trees, prior to death, produced new growth in the spring since photosynthesis and transpiration (evaporation) are necessary to produce whatever forces are required to transport water to the uppermost regions of the crown; remembering also, that many of the trees had little or almost no green crowns in 1989. Once transpiration ceases, the water column is broken, gravity takes over, and the column descends under its own weight through the xylem with the greatest pressure (both

Table 1.--Estimates of crown injury, tree mortality, and new growth of winter- (1989) damaged conifers made during 1989 and 1990.

| Location | Tree Spp.[1] | Avg. DBH (In.) | Year Examined | Trees Examined | Crown Damage Rating 4,0 | 4,1 | 3,1 | 3,2 | 2,2 | 2,3 | 1,3 | 1,4 | Dead 0,4 | New Growth Yes | New Growth No | Year Examined |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Number of Trees | | | | | | | | | | | |
| Bryan Cr. | LP | 9.4 | 1989 | 25 | 0 | 2 | 3 | 0 | 7 | 0 | 7 | 6 | 0 | 22 | 3 | 1989 |
| Helena NF | | | 1990 | | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 20 | 4 | 21 | 1990 |
| Bullion Park | LP | 12.7 | 1989 | 25 | 0 | 1 | 4 | 0 | 2 | 0 | 3 | 15 | 0 | 20 | 5 | 1989 |
| Helena NF | | | 1990 | | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 22 | 3 | 22 | 1990 |
| Granite BT | LP | 11.4 | 1989 | 25 | 0 | 0 | 2 | 0 | 9 | 0 | 5 | 9 | 0 | 12 | 13 | 1989 |
| Helena NF | | | 1990 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 24 | 1 | 24 | 1990 |
| Porcupine Cr. | LP | 8.7 | 1989 | 25 | 0 | 0 | 4 | 0 | 8 | 1 | 10 | 2 | 0 | 24 | 1 | 1989 |
| Deerlodge NF | | | 1990 | | 0 | 2 | 9 | 0 | 4 | 0 | 1 | 0 | 9 | 14 | 11 | 1990 |
| Cave Gulch | DF | 12.1 | 1989 | 25 | 0 | 0 | 6 | 0 | 9 | 0 | 8 | 2 | 0 | 6 | 19 | 1989 |
| Helena NF | | | 1990 | | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 10 | 12 | 11 | 14 | 1990 |
| Copper Cr. | ES | 13.2 | 1989 | 25 | 0 | 2 | 3 | 0 | 8 | 0 | 0 | 12 | 0 | 23 | 2 | 1989 |
| Helena NF | | | 1990 | | 0 | 3 | 1 | 0 | 3 | 0 | 3 | 3 | 12 | 11 | 14 | 1990 |
| Betty Cr. | WP | 24.1 | 1989 | 25 | 0 | 0 | 1 | 0 | 3 | 0 | 10 | 11 | 0 | 25 | 0 | 1989 |
| Flathead NF | | | 1990 | | 0 | 8 | 15 | 0 | 2 | 0 | 0 | 0 | 0 | 25 | 0 | 1990 |

[1]LP = Lodgepole pine, DF = Douglas-fir, ES = Engelmann spruce, WP = Western white pine.

Figure 2.--Heavy exudate issuing from bole of dead lodgepole pine.

vertical and horizontal) being exerted in the lower bole. The fermentation process by which the milky exudate is produced or its chemical makeup is unknown.

The 2-year sequence of photographs taken of individual trees and stands provides a visual record of their present condition, including permanent damage, mortality, or signs of recovery.

## DISCUSSION

There is little doubt that stands of lodgepole pine were highly vulnerable to winter injury, more than other coniferous species (Figure 3.). At this time, it is difficult to determine whether or not the trees that survived through 1990 will recover. We believe, however, that additional trees will die in 1991, particularly those with a low live/dead crown ratio (Table 1.) and those with meager live crowns.

Many lodgepole pines in reproduction areas exhibited severe crown injury in 1989, but most experienced good recovery in 1990. It is believed that the younger, faster growing trees are considerably more resistant to permanent cold injury than their mature and overmature neighbors.

Figure 3.--Winter damage to a lodgepole pine stand in 1989 (above) and 1990 (below). Note the two mature subalpine firs in the background which showed no noticeable injury in 1989.

Ponderosa and western white pine in certain areas showed significant foliage injury in 1989, but most appeared to recover in 1990 (Figure 4.). Possibly the worst immediate effects will be growth loss and vulnerability to bark beetle attack. Some ponderosa reproduction was damaged so heavily that it did not recover (Figure 5.).

Spectacular "winter burning" of subalpine fir occurred in exposed areas of Glacier National Park. This will perpetuate the long-standing Krummholz effect, resulting in "bushy" trees due to frequent killing of the tops that were not insulated by snow cover.

The Montana forests received normal precipitation in 1989 and 1990, following 3 consecutive years of drought. This moisture couldn't have come at a better time, since it may allow many of the "border line" trees to survive.

Western spruce budworm larval counts and moth catches were highly erratic in 1990 within the Douglas-fir type. Budworm numbers seemed to coincide with the amount of available foliage in 1990. Generally, stands experiencing winter damage had the lowest counts, while undamaged stands had more or less normal counts. For example, in the upper reaches of Orphin Creek on the Helena National Forest where winter injury was extensive (Cave Gulch Plot, Table 1.), previously abundant budworm populations were practically nonexistent in 1990[2] (Figure 6.).

It is recommended that these surveys be repeated in 1991 as a followup to ascertain the fate of the remaining live trees in the re-examination plots and to provide a long-term visual record of the condition of the apparently recovering trees in the photo plots.

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[2]Personal communication with Lawrence E. Stipe; Entomologist; Timber, Cooperative Forestry, and Pest Management; USDA, Forest Service; Missoula, Montana.

Figure 4.--Heavily damaged ponderosa pine in 1989 (above) showing partial recovery in 1990 (below).

Figure 5.--Ponderosa pine saplings heavily damaged in 1989 (above) and dead in 1990 (below).

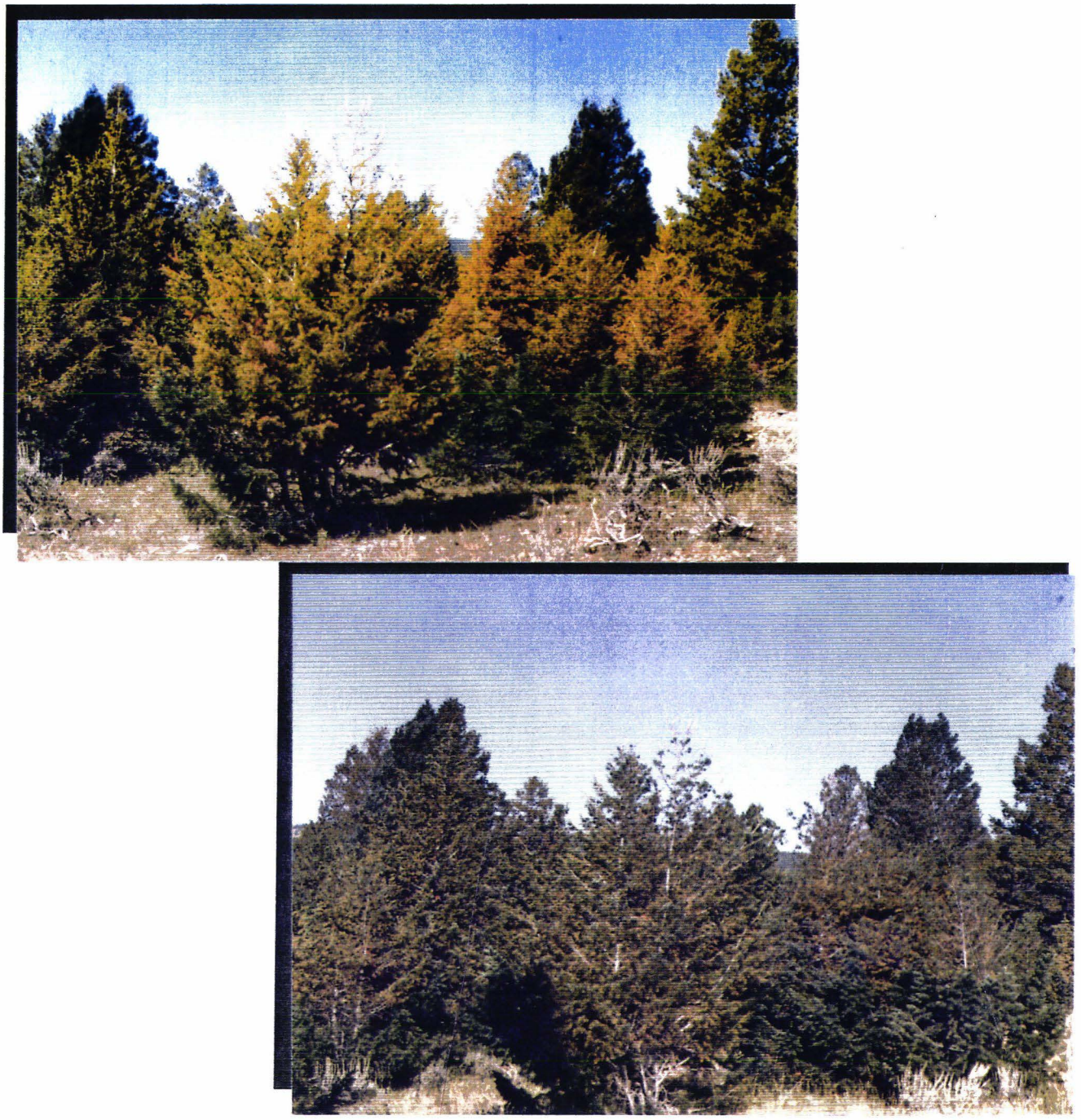

Figure 6.--Winter-injured Douglas-fir showing some recovery in 1990 (below). The lower crowns were protected from injury by snow cover in 1989 (above).